AU/AWC/98-234/1998-04

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GLOBAL BROADCAST SERVICE

AN ASSESSMENT OF POTENTIAL MILITARY-COMMERCIAL INTEGRATION

by

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A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

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Maxwell Air Force Base, Alabama

April 1998

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
01-04-1999

2. REPORT TYPE
Research

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Global Broadcast Service An Assessment Of Potential Military-Commercial Integration.

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Frank N. Tempia

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

HQ USAFA/DFES
USAF INSS
2354 Fairchild Dr., Ste 5L27
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

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USAF INSS
2354 Fairchild Dr., Ste 5L27
USAF Academy, CO 80840

HQ USAF/XONP
1480 AF Pentagon, Room 5D518
Washington, DC 20330-1480

10. SPONSOR/MONITOR'S ACRONYM(S)
HQ USAFA/DFES, HQ USAF/XONP

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

A Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Global Broadcast System Service (GBS) is a satellite communications system, which upon acquisition and implementation, will provide a high-speed, one-way data communications broadcast capability, that is, high-volume information transmission worldwide directly to in-theater warfighters. The issue is to determine whether to lease bandwidth or time on commercial satellites or developing and building military satellites is the most effective and efficient approach to implement such a system as GBS. This paper first will describe briefly the technology employed in satellite direct broadcast systems such as GBS and DirecPC and the communications requirements these systems satisfy. It further presents a moderately detailed technical description of GBS in order to make comparisons and demonstrate similarities with commercial satellite direct broadcast systems. It then discusses the benefits and accompanying risks and challenges associated with the integration of GBS into commercial direct broadcast systems. Finally the paper will assess the potential for the military-commercial integration of GBS with another commercial direct broadcast systems.

15. SUBJECT TERMS
Global Broadcast System, Military-Commercial, DoD, USAFA

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	Unclassified Unlimited	37	DR. JAMES M. SMITH / 719-333-2717

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Contents

Illustrations

Page

Tables

Preface

As we approach the millenium we continue to encounter, both in our private and professional lives, incredible advances in computer and communications technologies. Noteworthy advances seem to occur more and more frequently. For example, only three years ago in January of 1994, World Wide Web (WWW) sites were established and access was provided by early versions of web browsers such as Netscape and Internet Explorer. Approximately 1,250 Web sites were online. Since then, the WWW has undergone dramatic changes in size, scope, and technology. Today, more than 1,000,000 World Wide Web sites exist.[1] And the number of sites continues to grow exponentially. Today's WWW presents vast amounts of information at our ready access. The Web and other computer and communications technologies have significantly changed our daily lives by giving us this easy and inexpensive access to a growing universe of information.

Potentially, the warfighter, using this new technology, has gained access to vast amounts of textual, graphic, sound, and video information, not only from historical archives but also from near real time sensors and other data gathering activities. He has also the potential to obtain an increasing amount of information upon which to base critical decisions for deployment and employment of forces. The major impediment, however, is available communications technology, capable of disseminating, or providing, this expansive information base to the end users, or warfighters, where, when, and how they wish to receive it. The US Air Force Global Broadcast Service (GBS) will

provide that kind of capability. GBS is an important segment of the computer and communications technology base that will give the warfighter Information Dominance. As part of that system, DoD will adapt commercial, direct broadcast, digital satellite communications technology to provide real-time logistics, weather, and intelligence information to military forces. Commanders equipped with terminals as small as 18 inches will receive instantaneous, secure, high-data-rate information to out-smart, out-maneuver, and out-fight any opponent.[2]

One important question is whether the DoD should adapt commercial, direct-broadcast, digital satellite communications technology and build military satellites, or can and should the DoD, instead, purchase commercial communications services that are already available. The DoD has recently often experienced the acquisition dilemma of developing its own capability or buying a commercially available equivalent, sometimes known as commercial-off-the-shelf (COTS) systems. In recent years, this dilemma has grown more intense, especially regarding computer and communications technology, as commercial technology becomes more advanced, perfected, inexpensive, sophisticated, reliable, available, and cost effective. Large costs, as well as remarkably enhanced warfighting capability, are involved in satellite communications systems acquisitions and, as a consequence, the make or buy decision for GBS is a very important decision.

The US Air Force seems committed to development of a complete military solution for GBS, including communications satellites, rather than the purchase of commercial satellite services. I obviously do not attempt to change that decision and I recognize that this decision embodies technical, acquisition program, and political complexities that could not be adequately addressed with this paper. Nevertheless, we should continue to

examine decisions to develop or purchase commercial computer and communications technology. This paper is intended to provoke thought about the use of commercially provided technologies, not only for GBS but for other DoD computer and communications systems in general.

Notes

[1] "GVU's 7th WWW User Survey", Graphics, Visualization, & Usability Center, College of Computing, Georgia Institute of Technology, Atlanta, GA

[2] "Supplement, Budget of the United States Government, Fiscal Year 1997", The Budget of the U.S., FY 1997, Online via GPO Access, DOCID:1997_sup_bud04-1, wais.access.gpo.gov, p. 45.

Abstract

The Global Broadcast Service (GBS) is a satellite communications system, which upon acquisition and implementation, will provide a high-speed, one-way data communications broadcast capability, that is, high-volume information transmission worldwide directly to in-theater warfighters. The issue is to determine whether to lease bandwidth or time on a commercial communications satellites to provide this data transmission capability or to develop, build, launch, and operate military satellites for that capability; and whether leasing time on commercial satellites or developing and building military satellites is the most effective and efficient approach to implement such a system as GBS.

The program plan for GBS initially proscribes the use of commercially available satellite technology. The commercial satellite industry recently has experienced incredible growth, well able to support the plan. For example, in the United States, DirecPC, a commercial product of Hughes Corporation, provides communications services very similar to that planned by GBS. The Department of Defense recently awarded the prime GBS contract to Hughes.

Given the common technical base and existence of viable commercial systems, this paper asserts that excellent potential exists for successfully using commercial direct broadcast systems, like DirecPC, as the provider of satellite communications services for military GBS. DirecPC, and/or other similar commercial direct broadcast satellite

systems, could provide this communications service to satisfy the military requirement for high-speed, high-volume information transmission. Further, this paper argues that this integration would yield benefits to the DoD in the form of lower total costs by creating efficiencies in using common technical systems and in the form of continued refreshment of technology by relying on the commercial sector to maintain an advanced, contemporary technology base in the system.

This paper first will describe briefly the technology employed in satellite direct broadcast systems such as GBS and DirecPC and the communications requirements these systems satisfy. It further presents a moderately detailed technical description of GBS in order to make comparisons and demonstrate similarities with commercial satellite direct broadcast systems. It then discusses the benefits and accompanying risks and challenges associated with the integration of GBS into commercial direct broadcast systems. Finally the paper will assess the potential for the military-commercial integration of GBS with another commercial direct broadcast systems.

Chapter 1

Global Broadcast Service – An Overview

Commercial industry pioneered the development of direct broadcast television service using high bandwidth satellites and sophisticated receiver electronics technology to deliver large throughput in the form of many video "channels" directly into consumers' homes via very small (18" - 24") antennas and affordable, compact "set top" receiver electronic boxes. This same technology, made affordable by the ability to amortize costs over millions of commercial production units, is readily adaptable to military needs. This segment of commercial direct broadcast service (DBS) is tailored specifically for the television market. However, the technology embodied in television DBS now has been modified to provide high speed, high bandwidth data transmission over satellite direct to very small receiving units and computers. DirecPC is a commercial example of this type of direct broadcast service. This type of direct broadcast service can be used to serve the information needs of military users for a variety of high-volume data and video products. These include high-resolution imagery, weather, mapping, situational awareness, logistics, and multiple video services. The Global Broadcast Service will provide these data, graphic, and video services to military users and the system will be built upon the foundation of commercial and commercial-like direct broadcast technologies. Properly implemented, GBS promises to become a

significant enabler of dominant battlefield knowledge, which will contribute to future success in military operations.

Capitalizing on commercial efforts in a highly cost-competitive marketplace, GBS will be incorporated into existing military satellite communications (MILSATCOM). It will provide high-speed, one-way flow of high volume data to units in garrison, deployed to the field, or moving between or within theaters of operations. This separate path for high-speed flow of high volume data will increase the capacity of existing and planned two-way communications systems and help these systems support lower volume communications needs of forces and also provide the means for GBS user requests. The GBS system will not replace existing MILSATCOM systems. It will support existing CINC requirements by providing the capability to quickly distribute products with large information content to deployed users. These information products will be developed and distributed using a "Smart Push and/or User Pull" philosophy to avert saturating deployed forces with information overload, that is, users will receive only those products which they have requested. GBS will be an integral part of the overall DoD MILSATCOM Architecture and the larger Defense Information Infrastructure (DII). As such, it will employ an open architecture that can accept a variety of data formats. It will interface with, and support major DoD and theater information systems that are DII Common Operating Environment (COE) and Joint Technical Architecture (JTA) compliant such as the Global Command and Control System (GCCS). The system will exploit commercial off-the-shelf (COTS) computer and communications technologies and services.

GBS will be implemented using a three-phased approach. This approach provides significant capability quickly in the first phase, and then expands in later phases to meet growing communications needs. The GBS program acquisition office will continually assess available technical options to determine the exact timeline for fielding the system. Also, the program approach does not attempt to predict the architecture of the future integrated satellite communications (SATCOM) systems currently under development. This is critically important to this assessment and gives much needed flexibility in the decision of whether to develop military satellites to provide direct broadcast communication services or purchase already available and developed commercial satellite services.

The three phases to GBS development are described below in some detail in order to indicate the initial use of commercial satellite services and then the increasing dependence upon developed military satellite assets. Phase 1 of the GBS program, scheduled for fiscal year (FY) 1996 to FY 1998, is described as a limited demonstration. The system during Phase 1 will use leased commercial satellite services operating in the Ku-band. The purpose of the system during this phase will be for developing the concept of operations, giving technology demonstrations, and providing limited support in operational situations. The focus of Phase 1 is to acquire and provide a limited off-the-shelf commercial capability to support selected exercises and concept development; to develop in-theater injection capability; and to initiate connectivity from information producers to GBS.

Phase 2 is planned for FY1998 to FY2006 and described as an interim military satellite capability. The program will launch military UHF Follow-On (UFO) Satellites

8, 9, and 10 with a capability for downlink broadcasting operating at military K_a-band. Because only three UHF Follow-On satellites will be equipped with the GBS K_a-band broadcast capability, the continued lease of commercial satellite services at K_u-band will be required during this phase to augment military satellite GBS where coverage gaps exist and may be required to complement the military satellite GBS limited number and size of downlink beams. In addition to incorporating lessons learned from Phase 1, Phase 2 will launch Ultra-High Frequency (UHF) Follow-on satellites 8, 9, and 10 with hosted GBS packages; lease commercial satellite services to augment a GBS coverage gap over the continental United States (CONUS); continue to develop GBS hardware and software products as technology evolves; and integrate GBS with MILSATCOM architecture and the DII.

Phase 3 is described as the objective system and scheduled for beyond FY 2006. As planned through the program, the objective GBS on-orbit capability will provide increased capacity, worldwide coverage, and the capability to broadcast near continuous or time critical information to broadly dispersed users. The specific solution for the GBS long-term capability will be developed in accordance with the DoD MILSATCOM Architecture as maintained by the DoD Space Architect. And, as previously stated, this approach does not attempt to predict the architecture of the future integrated satellite communications (SATCOM) systems currently under development. Upon the foundation of Phase 2 operations and user segment development, Phase 3 GBS will complete acquisition of military space, ground, and user segments. At this critical juncture in the program, the DoD must make the decision of whether to continue to develop, build, and operate military satellites to provide direct broadcast communication services; to

purchase already developed and available commercial satellite services; or to employ a some mix of military and commercial satellite communications assets.

GBS is an approved joint program, with Air Force as the Executive Agent. The Under Secretary of Defense for Acquisition and Technology (USD(A&T)) formally established the program on 27 March 1996. The military services are required to provide adequate funding to meet the requirements contained in the approved Operational Requirements Document (ORD). The GBS program includes funding for the establishment and installation of Satellite Broadcast Management centers; contractor manning and operation for three years; GBS communications packages on military satellites UFO 8, 9, and 10; and initial distribution of 150 receive suites consisting of receive terminal and receive broadcast manager hardware and software.

The Global Broadcast Service will employ very similar technologies as that upon which DirecPC and other commercial direct broadcast systems are based. The following Figure 1 illustrates the DirecPC system architecture.[1]

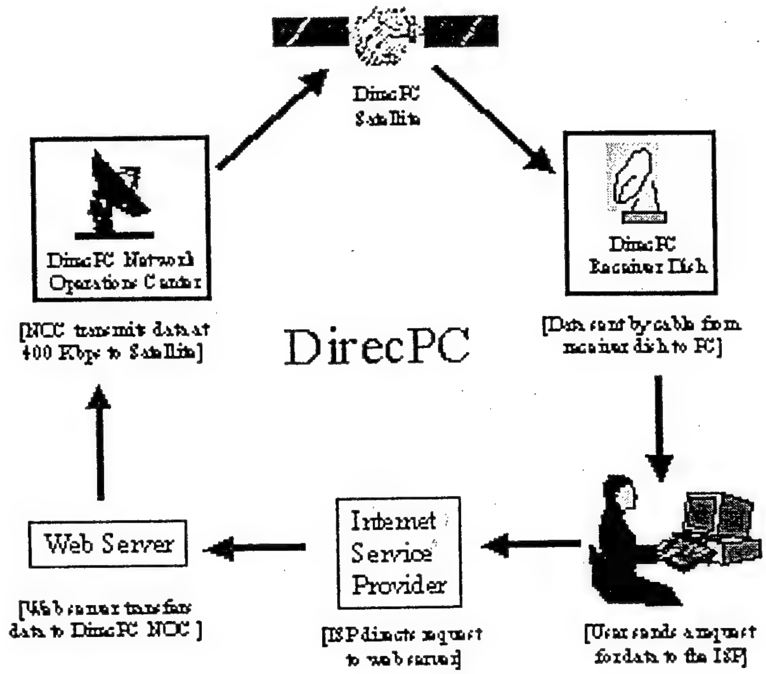

Figure 1. DirecPC Systems Architecture

Direct broadcast systems, such as DirecPC and GBS, achieve high-speed, high-volume information transmission using advanced satellite technology, rather than slower terrestrial computer networks and telephone systems. GBS, similar to DirecPC, will be a system of broadcast managers, injection points, broadcast satellites, receiver terminals, and the management processes for requesting and coordinating the distribution of information products (refer to Figure 2). Note the strong similarity in systems architecture between DirecPC and GBS.

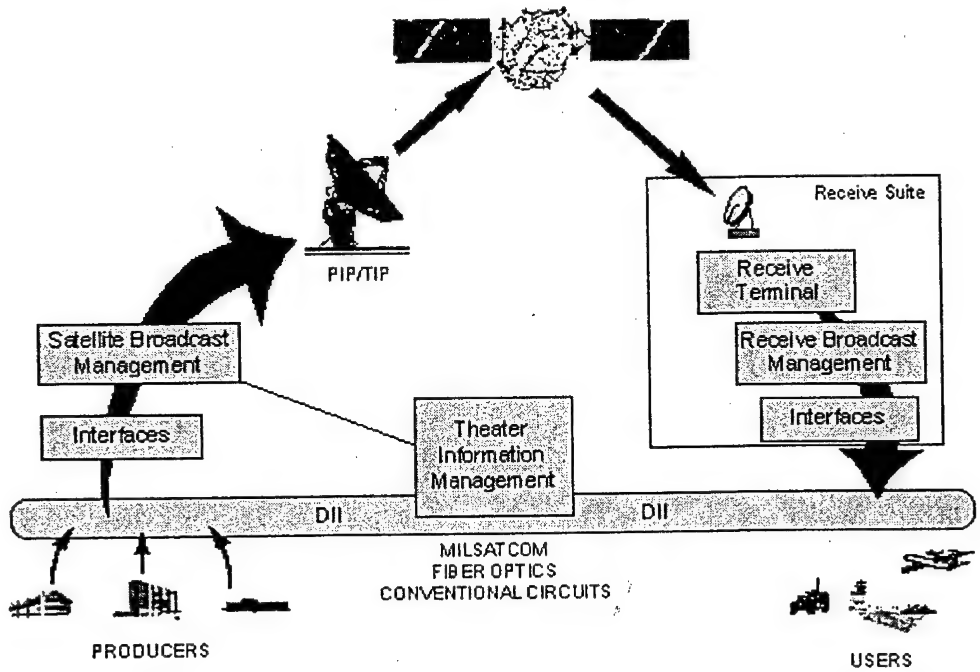

Figure 2. GBS Systems Architecture

Both GBS and DirecPC download information from the Internet, and for the DoD, the Defense Information System Network (the DoD segment of the Internet), from the computer (or web) server to the direct broadcast satellite network and directly into user networks or PCs. The user issues the request for information, which is usually small in content, over traditional networks and circuits. The source computer or server then transmits the requested information, which may be quite large in size because of graphics (e.g., intelligence or weather information) or large amounts of text (e.g., an Air Tasking Order), over the high-speed, high-volume satellite links. Therefore, we may characterize GBS as an extremely high throughput system, using a very wide bandwidth, for the rapid broadcast of high-volume military information. The system will deliver information in

seconds, compared with minutes or hours needed in the past, using traditional and common desktop computer interfaces. GBS will enable U.S. troops around the world to receive data at rates of more than 23 Megabits per second (Mbps) via satellite. GBS, similar to other commercial direct broadcast systems such as DirecPC, will provide information to large populations of dispersed users with small, mobile receive satellite terminals. These satellite terminals will allow data dissemination directly to lower-echelon forces, providing current weather, intelligence, news, imagery, and other mission essential information.

High-data-rate satellite terminals are characteristically large and fixed. In the GBS systems architecture, terminals are small, mobile, and provide high-volume data directly into 1-meter or smaller antennas. Mobile force elements, free from restrictive large fixed terminals, will be able to receive information formerly relegated only to command centers. As previously stated current technology can support data rates between 1.544 and 24 megabits per second (Mbps) per transponder or higher. GBS broadcasts will enable timely delivery of large-data-file products to a family of scalable terminals. The current GBS program documentation states that existing commercial equipment may need modification in order to meet fully some specialized military requirements in all areas of the world.[2] Each GBS satellite will be managed by a satellite broadcast manager and primary injection point. GBS will also have the capability to inject information products directly from the theater. Since GBS enables the storage, retrieval and dissemination of huge information files that could quickly exceed the capability of most mobile users, the tailoring of a "smart push and/or user pull" dissemination architecture for GBS is a significant challenge. GBS broadcasts will be one-way only; they will only

distribute information. Requests for information (user pull) will be made via other existing communications means. Figure 3 illustrates this GBS conceptual architecture described above.

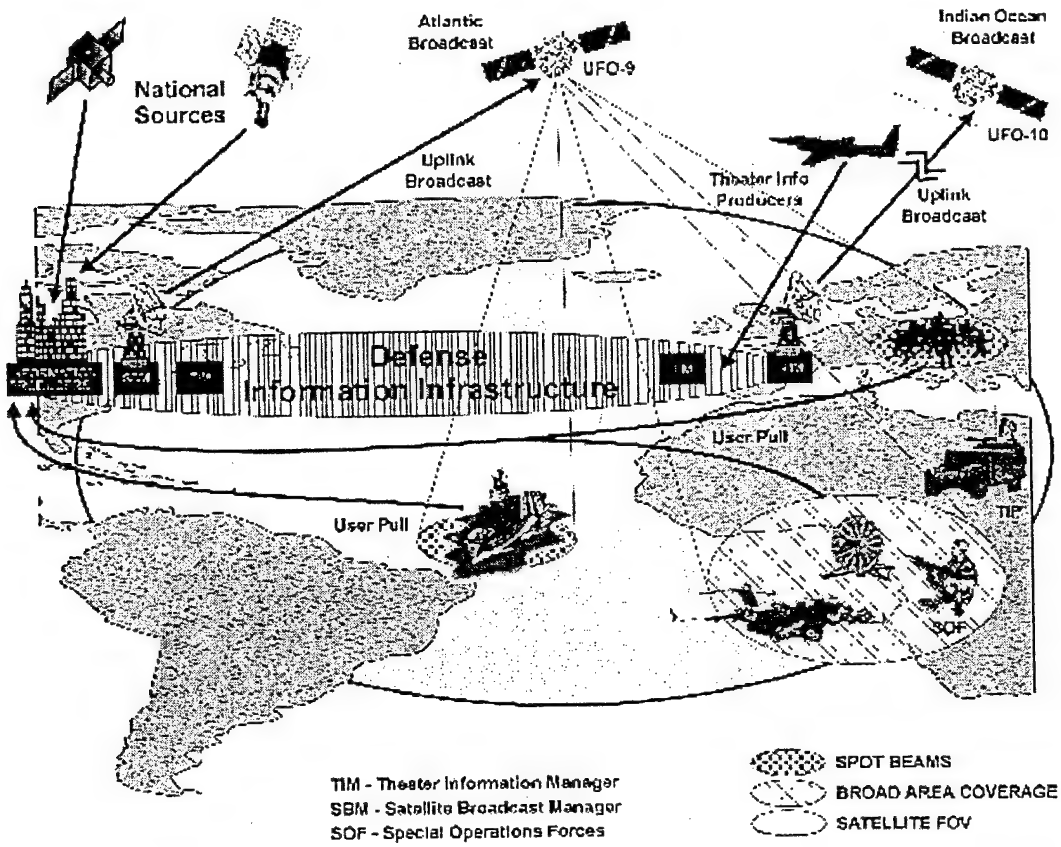

Figure 3. GBS Conceptual Architecture

The DoD has selected Hughes Information Systems (HIS), a unit of Hughes Aircraft Co., as the prime contractor for the Global Broadcast Service (GBS) contract.[3] Hughes also has developed and owns and operates DirecPC. And similar to other space programs, primarily because of the unique, one-of-a-kind developed and built military satellites, GBS is expensive. The initial contract value is less than \$100 million, but additional contract options could add an estimated \$200 million over the next several

years. Hughes has developed a design concept that maximizes the use of rapidly evolving commercial broadcast and web technology. However, the DoD has also proscribed unique military requirements for GBS, such as for security and ruggedness, which will complicate military/commercial technology integration and decrease the potential for success of this integration. The contract awarded to HIS by the Air Force Space and Missile Systems Center in Los Angeles will provide for the development, system integration and engineering, and procurement of hardware and software for the GBS system, both at the broadcast and receive ends. Three Ultra-High Frequency Follow-on (UFO) satellites, being developed and launched for the U.S. Navy by Hughes Space and Communications Co., will carry the GBS capability during Phase 2. The first GBS satellite is scheduled for launch in 1998.

In summary, the current DoD GBS acquisition program will implement GBS in three phases over six years. Phase 1 will consist of leased commercial satellite transponders, in order to acquire an initial capability rapidly. Phase 2 will consist of GBS packages aboard three military satellites. Phase 3 will be the full system, which could consist of military assets, a commercial leased system, or a combination of the two. Note that the DoD has not decided finally about the composition of the Phase 3 full system with regard to the use of military and commercial assets.

As the DoD, through the GBS program, plans for development and implementation of this critical communications capability, senior decision makers must consider the best combination of commercial and military communications assets on which to build it. The DoD can achieve enormous benefits by employing commercial technology, but depending completely upon the commercial sector carries certain risks and challenges.

We first examine some benefits related to using commercial technology and communications assets for GBS.

Notes

[1] DirecPC Web Page, *www.direcpc.com.*

[2] The draft Joint Global Broadcast System Concept of Operations, Version 2, dated 15 September 1997, asserts that military modifications may be necessary but does not describe them or explain the rationale for them.

[3] "Hughes Selected for Global Broadcast System Contract", *Business Wire*, November 25, 1997.

Chapter 2

Benefits of Military-Commercial Integration

The U.S. military has changed substantially after the end of the Cold War in the early 1990s. Many persons regard the change as beneficial, yet challenging and difficult. New technologies have made our military forces more lethal and effective than could have been imagined just a few short years ago. Among numerous technological innovations, stealth, faster and smaller computers, and innovations in data communications, including fiber optics and satellites, have changed the battlespace and given a far superior edge to U.S. military forces.

However, increased capability derived from superior technical advantages in computers and data communications, comes with a cost. Research into computer and communications technologies to maintain a leading technology position and then subsequent development of those technologies into implemented satellite systems is very expensive. The DoD must account for continued decreasing funding and budgets as it makes decisions regarding development and fielding of satellite systems. One part of the answer to this dilemma may be found in employing commercial technology within military satellite assets without making significant military modifications. Another part of the answer may be the purchase of a commercial satellite communications service to replace the development, implementation, and operation of military satellite

constellations. We will now discuss the possibilities for the purchase of a commercial satellite communications service and describe the benefits of this type of military-commercial technology integration.

Commercial space, especially commercial direct broadcast communications technology is presently experiencing dramatic and convincing growth. (This growth is discussed in much more detail in Chapter 4 while assessing the military-commercial integration potential.) Satellite communications technology, such as used in DirecPC, is now widely available in the United States. This availability impacts directly upon GBS and its implementation. Also other direct broadcast systems, similar to DirecPC, presently also operate in Europe and East Asia. Worldwide satellite coverage is expected to become commercially available by 2003. The DoD will employ these existing commercial assets to implement an initial capability as planned in Phase1 of the GBS program. In Phase 1 of GBS, DoD will purchase a commercial direct broadcast service by leasing transponders on commercial satellites. Military-commercial integration both strengthens the commercial sector by increasing the customer base and, also, immediately gives the military this much needed communications capability without the need for an expensive satellite development/acquisition program and the time and overhead associated with it. Even before GBS Phase 1 begins, the DoD has implemented a GBS prototype direct broadcast system, the Joint Broadcast System (JBS), for testing and use during peacekeeping operations in Bosnia.

The Joint Broadcast System, an operational prototype and precursor to the programmed GBS, is an excellent example which illustrates the benefits that available commercial technology, capability, and services can provide when embodied within

military computer and communications systems and employed during operations. Aboard Air Force C-135 Speckled Trout, the JBS gives commanders in Bosnia a vastly better grasp of every aspect of the battlefield than ever before.[1] JBS links multiple systems used for command, control, communications, computers and intelligence (C4I), surveillance and reconnaissance and then provides, using commercial satellite broadcast services, U.S. and allied commanders at every echelon a common operating picture. This picture allows commanders executing the peacekeeping operation to coordinate operations closely from anywhere in the world. The common operating picture also displays maps, imagery and updated intelligence showing locations of enemy and friendly forces, their relative strengths and compositions. The prototype JBS is a true success story not only because the system provides much more complete and near real time information about the battlespace than warfighters have ever possessed, but also because the DoD had developed and implemented the system for operational use much more rapidly than most computer communication systems. The JBS employs commercial satellite assets, that is, leased commercial satellite transponders, to provide this communications service to warfighters in Bosnia.

The use of available commercial computer and communications technologies, assets, and services is one major reason for that rapid implementation. The ready access to commercial technology and services allows rapid provision of capability, in this case critical communications capability, to warfighters. Using commercial satellite assets allowed the DoD to provide this capability quickly.

The DoD intends to use a combination of commercial and military communications assets in the final GBS configuration. GBS will link communications worldwide using

not only leased commercial transponders, but also using dedicated military satellites, fiber-optic lines and radio networks. Military satellites will carry GBS satellite communications traffic, as will commercial Inmarsat satellite transponders, which will transmit some noncritical, unclassified information. However, as the GBS is implemented, especially by Phase 3, the system is planned to rely solely upon military satellites for direct broadcast communications capability. With this increasing dependence upon development of military technology and assets, it is imperative to determine the most effective and efficient way for GBS to remain responsive to the needs of the warfighter – develop, implement, and operate military satellites or purchase commercial satellite communications services. Again, this is a serious issue that decision-makers must consider when planning the best combination of commercial and military communications assets on which to build GBS.

Using commercial satellite technology, or even more, commercial satellite communications services similar to DirecPC, also gives other benefits, in addition to ready availability. As a commercial business, DirecPC and other commercial firms must maintain technical superiority in order to maintain and grow a solid customer base. Competition forces the industry to continually research and develop newer and better communications and satellite technologies. When the DoD purchases the communications service rather than develop the technology, it leverages the vast research and development capability of the whole industry. Because the commercial industry possesses much more resources for research and development than the military, it could refresh technology and maintain a leading technological edge within the Global Broadcast Service much more responsively, effectively, and efficiently. As a result, the

system would remain on the cutting edge of technology. And although the military would pay for research and development (R and D) activities though service fees, the large customer base shares the R and D costs within the industry and therefore specific R and D costs for the military would be much less. There may be significant questions regarding whether the military should pay for expensive research and development of direct broadcast systems if commercial industry can perform this activity (and possibly do it better).

The DoD then could realize several extremely significant benefits from the purchase of commercial satellite communications services for the Global Broadcast Service. These benefits derive from the spectacular growth in the commercial space sector. First, contemporary communications technology would be readily available to the program. As commercial firms continue to develop the technology, it becomes readily available to refresh GBS and continue to increase its technical capability. Second, commercial space communications firms will continue to research and develop the technology. The DoD does not have the funding resources to maintain this technology edge and must rely on the commercial sector. Finally, the DoD could attain cost efficiencies by purchasing this satellite communications service for GBS. Commercial firms, because of economies of scale (recall the enormous growth in the space industry) simply will be able to research, develop, and provide this satellite communications service much more efficiently, and therefore, economically, than the DoD.

Although the DoD can achieve great potential benefits from military-commercial integration of direct broadcast technology, senior decision-makers must also be aware of serious risks and challenges derived from that integration.

Notes

[1] Pat Cooper, "Battle with a Better View Via Global Broadcast", Army Times, September 9, 1996, Vol. 57, Issue 9, p.32.

Chapter 3

Risks and Challenges of Integration

The concept of military-commercial integration is attractive from the perspective of the benefits previously discussed, which includes ready availability, continued technical effectiveness and responsiveness, and cost efficiency. However, policies directed at integrating military and commercial satellite communications services not only accrue benefits but also possess a number of inherent risks and challenges. Risks and challenges involve and relate to data security; denial of service, also described as the defense of U.S. and allied commercial space-based satellite constellations; the denial of enemy use of commercial space satellites; and the full, seamless integration of the commercial satellite communications service with military ground assets.

Security of data transmitted by either military or commercial satellite has great importance. If the DoD purchases commercial satellite communications services, those commercial systems would transmit military data. In many cases, that military data could be classified and/or critical to military operations. Therefore, the transmission of military data over commercial satellite links could incur such risks related to the protection of classified data.

Transmission of data classified as SECRET or higher over commercial satellite links could create a serious security risk for GBS. Commercial systems that transmit both

unclassified and classified information always present the risk and challenge that unauthorized users would or could acquire sensitive, classified information. Software and hardware encryption technologies provide the solution to this problem. However, GBS managers and users must remain vigilant to ensure secure data transmission.

During the early part of 1996 an interagency conflict occurred, which, if nothing else, illustrated the perception that GBS is a sensitive military system and requires a major military not commercial technology segment, if not a full military solution.[1] GBS, which will deliver voice, video and data to the military and (note the key word) intelligence communities, became the subject of a territorial dispute between two U.S. agencies. National security panelists revealed at an April 1996 Space Symposium that the National Reconnaissance Office (NRO), which oversees the nation's intelligence satellites and at that time managed much of the GBS development through a Naval Research Laboratory facility, fought attempts by the Defense Information Systems Agency (DISA) to take control of GBS. The interagency attempt for control of GBS was based upon the NRO desire to use the service to provide high volume and highly classified intelligence information to the field and the DISA belief that the service would benefit the warfighter by providing critical high volume information, both classified and unclassified.

The NRO argued that GBS will carry a high volume of one-way highly classified information, including Air Intelligence Agency tactical intelligence broadcasts and the National Security Agency's Binocular intelligence broadcast system. GBS will also carry data from two classified, global networks. One of these networks, the SIPRNET, the

Secure IP Router Network, carries information that includes intelligence images, Tomahawk cruise missile contour mapping data, and defense weather-system data.

Jeffrey Grant, the NRO director of plans and analysis at the time, said the agency hopes to provide as much intelligence to the field as possible without unduly risking security.[2] One conclusion of the NRO argument holds that because GBS potentially will contain such highly classified information, the system requires a major military not commercial technology segment, if not a full military solution. That is, in order to minimize the risk, GBS must have secure, military circuits.

GBS will solve this problem using encryption technology. In addition, the challenge of building a secure network for classified information using commercial direct broadcast satellite services may require a combination of some military satellite communications assets in addition to the purchase of the commercial satellite communications service.

Another risk involves the denial of communications service by the enemy. This risk may also be described as the defense of U.S. and allied commercial space-based satellite constellations. In future armed conflicts communications satellites could become vulnerable to attack and U.S. forces subsequently could be denied the communications service critical to warfighting success at precisely the time it is most needed. Potential adversaries probably do not have the capability at the present time to successfully stage an attack on space-based satellite constellations. However, the DoD must prepare for this possibility in the future. Defense of U.S. and allied commercial space-based satellites is clearly a new mission area for the U.S. Air Force. This new mission requires new technologies (weapons systems capable of defending satellites do not yet exist),

operational methods, and doctrine. The Air Force has begun work to develop these new technologies, methods, and doctrine.[3]

Another risk is the possibility that the enemy will have commercial satellite services available for their use during conflict with the U.S. With the growth of commercial satellite communications services most countries will have vast communications resources available. In fact, given the global nature and immense capability of these commercial services, it's entirely possible that prior to conflict the U.S. could share the resources of specific commercial satellites with future adversaries. The DoD must be able to defend these space-based satellite constellations and continue to employ their communications services while at the same time denying the use of the satellites to the enemy. This also is a new mission area for the U.S. Air Force requiring new technologies, operational methods, and doctrine. The Air Force has also begun development of the technologies and doctrine to support this mission area.

The DoD could mitigate the risks of enemy attack on vital commercial satellite constellations and of enemy use of these commercial communications services by purchasing services from most if not all commercial firms available.[4] This diversification of purchased communications service would make the loss of any one segment of the service to enemy attack much less consequential and significant. Also, to manage an acceptable level of risk, it may be important to maintain a certain level of military satellite communications capability (strictly military communications satellites as part of a completely closed military system) to provide for a critical core of military communications needs. In either case the DoD does have options and can act to mitigate these risks.

Finally, the risks and challenges related to military-commercial integration of GBS and commercial satellite communications services also include the inherent difficulty in the integration process. The DoD must provide a complete solution, which offers not only commercial satellite transmission services but also all military ground communications services. Military ground communications possess unique qualities because of the unique environment and situation within which the military operates. While satellite communications will become common and be offered as a commodity, ground communications for the warfighter will likely remain unique and require a military solution. The integration, or bringing together, of both the commercial and military segments for a total communications service could present several challenges. Again, the experience in Bosnia will illustrate this challenge.

The prototype Joint Broadcast System in Bosnia has resulted in significant improved operational capability in an extremely short period of time; however, it has not yet realized its full potential.[5] Early in its operational life, JBS mostly provided CNN (Cable News Network) to command centers. Watching sports events that are transmitted over extremely large communications links was not the objective of the Joint Broadcast System, yet the system initially lacked the software for mission critical operations. JBS was designed to provide relevant, timely information (specifically large data format information such as imagery and video) to operators, both US and coalition, as a remedy to the problem of insufficient communications links and resulting poor imagery quality found last year (available communications systems could not transmit the large files commonly associated with imagery). Critical work had to be done to develop new concepts, procedures, and supporting systems for exploiting the expanded

communications infrastructure provided by JBS. This same type of work will need to be accomplished, both locally and globally, in advance of the implementation of the Global Broadcast Service. Commercial firms may provide a robust satellite communications segment, but the DoD must integrate, or combine, that commercial service with satellite receivers, computers, other communications hardware, and system software on the ground to implement a complete system. The total solution necessarily becomes a combination of commercial and military concepts, procedures, communication technologies, and assets. Constructing this integrated solution will be a challenge.

Notes

[1] Loring Wirbel, "Agencies in Spy Network Scuffle", *Electronic Engineering Times*, April 22, 1996, Issue 898, p. 1.

[2] Ibid., p. 1.

[3] Dr. Daniel Hastings, *The Next Space and Air Force*, A briefing to the U.S. Air Force Air War College, March 23, 1998.

[4] Ibid.

[5] *Improved Application of Intelligence to the Battlefield*, A Defense Science Board Study, July, 1996.

Chapter 4

Assessment of Integration Potential

"America's national security and economic well-being have long rested on its technological and industrial prowess. Over the four-decades-long Cold War, the Nation's defense technology and industrial base became largely isolated from the commercial base, thus losing some of the benefits of the larger base. This isolation raised the cost of many defense goods and services, reduced defense access to fast-moving commercial technologies, and made it difficult for commercial firms to exploit the results of the Nation's large defense science and technology investments."[1] This evaluation from the Congressional Office of Technology Assessment accurately describes the technical and economic forces at work today. The DoD until recently has developed and employed unique military technical solutions and taken a separate and distinct path from commercial industry. Many military technologies crossed over to commercial applications but the DoD typically has not depended upon commercial industry for technology development and implementation. The economics of decreased military budgets however should now force the DoD to reexamine the assumed necessity of complete military technical solutions and to consider the wholesale purchase of commercial technology and/or commercial technical services, such as satellite communications services for the Global Broadcast Service.

Certain conditions definitely could lead to a decision for less rather than more wholesale purchase of commercial technical services and military-commercial integration. The following table provides guidance for this decision making process.

Table 1. Characteristics That Make a Defense Sector More or Less Amenable to Integration[2]

More Amenable	Less Amenable
Fills a similar defense and commercial need.	Has no related commercial variant (esp. weapons).
Readily customizable from commercial technology and processes.	N/A
Processes similar to commercial processes.	Process is specialized for performance of security reasons.
A service.	Sourced from a higher tier, especially at the prime integration level.
Economically viable volume/predictable rates.	Noncommercial volume/uneven rates.
Commercial technology leads defense technology.	Defense technology leads commercial technology.

Source: *Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices*, OTA-ISS-611 (Washington, DC: US Government Printing Office, September, 1994), 10.

However, conditions with regard to Global Broadcast Service development and implementation clearly indicate the need for more, rather than less, military-commercial integration. Read through each decision point in the above table. First, Commercial satellite communications fills a similar defense need. Also, the commercial technology involved is basic satellite communications readily customizable for defense purposes. The satellite communications process is very similar if not nearly identical. Commercial satellite communications is not only a service but, as subsequently described, also a commodity. Because commercial satellite services potentially have many thousands of users, they have economically viable volumes and predictable rates. And also in the

subsequent discussion in this chapter, we will describe the current explosion of growth in the commercial satellite industry, which will soon certainly lead defense in space and satellite technology. This assessment clearly indicates the need for more, rather than less, military-commercial integration with regard to GBS.

Today, commercial space is growing more than ever was expected just a few years ago. Dr. Daniel Hastings, Chief Scientist for the U.S. Air Force, has recently described this astounding growth in the commercial space sector.[3] Just a few years ago, the government dominated space; space systems were extremely expensive; and space launches were few. During 1997 to 2007, eighteen hundred new satellites will be launched (only five hundred active satellites now exist worldwide). More than $0.5 trillion has been invested by commercial firms. Currently the government accounts for only 6% of the total satellites launched. Commercial satellite launches will have a 40% growth rate; the government will have a 2% growth rate. Commercial firms are developing mass manufacturing techniques to reduce the cost of satellites. The government even now may require two to four years to develop and build a satellite; one firm now using these manufacturing techniques can build a satellite in months, sometimes days depending upon the type. The Wall Street Journal has described this growth in commercial space as the "Second Apollo Era".

Truly a commercial space revolution is in progress. One area of phenomenal growth is satellite communications. We now live in an rapidly expanding, communications rich environment. Commercial firms are currently developing satellite communications technology, which will provide greater than 900 Gbps globally to small (12 to 18 inches) size terminals. This enormous communications capability will likely be available in

2003. Commercial firms will be able to direct broadcast anything, anywhere on the globe. We already have robust growth of the Ka and Ku bands at geosynchronous earth orbit (GEO). The use of Low earth orbit (LEO) mobile communications (pocket phones) is exploding; as well as LEO multimedia direct broadcast to small terminals.

The impact on the U.S. military will likely be enormous. Communications and launch services will become commodities. Note that satellite communications is expected to become both a service and a commodity. As this becomes reality, the DoD very seriously must ask whether the U.S. Air Force should continue research into satellite communications technology, develop those technologies, and implement its own communications satellite constellations and resulting services; or recognize the growing dominance of the commercial space industry and purchase satellite communications services as the commodity it will become.

And this is a primary question with regard to the Global Broadcast Service. The military represents a diminishing share of the communications market place. Commercial satellite communications services increasingly will be available as a commodity. Commercial firms, backed by the vast and strong economic foundation of the marketplace, will be better positioned than the military to research and refresh the satellite communications technology employed and offered. The U.S. Air Force will be able readily to buy the satellite communications services. The argument for military development, construction, and operation of these services has become weak.

Finally, an assessment of the risks and challenges associated with the purchase of commercial satellite communications services reveals areas of concern, but not circumstances and/or environmental factors that cannot be overcome. The security of

classified and/or critical data is at risk. However, the DoD will solve this problem with encryption technology. In addition, the challenge of building a secure network for classified information using commercial direct broadcast satellite services may require some military satellite communications assets in addition to the purchase of the commercial service. GBS decision-makers recognize this and responded by planning to launch three military satellites during Phase 2. However, they must carefully appropriate and assign the proper amount of development and assets to this military specific requirement. The danger will lie in expanding the military segment to include requirements, which commercial direct broadcast systems and services could satisfy more effectively and efficiently.

Another risk involves the denial of communications service by the enemy. This risk was described as the defense of U.S. and allied commercial space-based satellite constellations. The U.S. Air Force is already preparing for this possibility in the future. Defense of U.S. and allied commercial space-based requires new technologies, operational methods, and doctrine, already under development by the Air Force. Closely related to denial of service is the possibility that the enemy will have commercial satellite services available for their use during conflict with the U.S. With the growth of commercial satellite communications services most countries will have vast communications resources available. Given the global nature and immense capability of these commercial services, it's possible that prior to conflict the U.S. could share the resources of specific satellites with future adversaries. The DoD must be able to defend these space-based satellite constellations and continue to employ their communications services while at the same time denying the use of the satellites to the enemy. The Air

Force has also begun development on the technologies, methods, and doctrine to support this mission area.

As previously stated the DoD could mitigate the risks of enemy attack on vital commercial satellite constellations and of enemy use of these commercial communications services by purchasing services from most if not all commercial firms available. This diversification of purchased communications services would make the loss of any one segment of the service to enemy attack much less consequential and significant. Also, to manage an acceptable level of risk, it may be important to maintain a certain level of military satellite communications capability (strictly military communications satellites as part of a completely closed military system) to provide for a critical core of military communications needs. In either case the DoD will have options to mitigate these risks.

Notes

[1] *Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices*, OTA-ISS-611 (Washington, DC: US Government Printing Office, September 1994), p.iii.

[2] Joan Johnson-Freese and Roger Handberg, *Space: The Dormant Frontier* (Westport, CT: Praeger Publishers, 1997), p.213.

[3] Dr. Daniel Hastings, *The Next Space and Air Force*, A briefing to the U.S. Air Force Air War College, March 23, 1998.

Chapter 5

Conclusions

The Global Broadcast Service will give vastly expanded communications capability to the warfighter. In this program, possibly more than most others within DoD, we have the opportunity to implement that capability using, at least in part, available commercial satellite assets, technologies, and services. This military-commercial integration would give the military immensely improved communications capability without the need for an expensive satellite development/acquisition program and the time and overhead associated with it.

The DoD could realize several extremely significant benefits from the purchase of commercial satellite communications services for the Global Broadcast Service. These benefits derive from the spectacular growth in the commercial space sector. First, contemporary communications technology would be readily available to the program. As commercial firms continue to develop the technology, it becomes readily available to refresh GBS and continue to increase its technical capability. Second, commercial space communications firms will continue to research and develop the technology. The DoD does not have the funding resources to maintain this technology edge and must rely on the commercial sector. Finally, the DoD could attain cost efficiencies by purchasing this satellite communications service for GBS. Commercial firms, because of economies of

scale simply will be able to research, develop, and provide this satellite communications service much more efficiently, and therefore, economically, than the DoD.

The concept of military-commercial integration is attractive from the perspective of these benefits. However, policies directed at integrating military and commercial satellite communications services not only accrue benefits but also possess a number of inherent risks and challenges. Risks and challenges include data security; denial of service, also described as the defense of U.S. and allied commercial space-based satellite constellations; the denial of enemy use of commercial space satellites; and the full, seamless integration of the commercial satellite communications service with military ground assets. The DoD will use encryption technology to solve the data security problem. Also, risks related to defense of satellite constellations and denial of enemy use of satellite communications can be mitigated by a purchasing commercial satellite communications service from multiple vendor sources and maintaining a military satellite core capability for transmission of the most critical and sensitive military information.

Commercial space is growing very rapidly and commercial satellite communications services increasingly therefore will be available as a commodity. Commercial firms, backed by the vast and strong economic foundation of the marketplace, will be better positioned than the military to research and refresh the satellite communications technology employed and offered. The U.S. Air Force will be able readily to buy the satellite communications services. And military development, construction, and operation of satellites to provide this available service will continue to make less sense.

The most likely decision for GBS should be a combination of military satellite assets, commercially provide satellite communications services, and military ground

communications systems. GBS will need a military satellite core capability for transmission of the most critical and sensitive military information. Yet the DoD can purchase and employ commercial satellite communications services for most GBS data transmission. And unique operational requirements will demand military ground communication systems and software.

The DoD should integrate military systems and commercial services in this way to provide the most effective and efficient Global Broadcast Service.

Glossary

ART	Airborne Receive Terminal
AOR	Area of Responsibility
BMC	Broadcast Management Center
CONUS	Continental United States
DII	Defense Information Infrastructure
DISN	Defense Information Systems Network
GBS	Global Broadcast Service
GRT	Ground Receive Terminal
IRD	Integrated Receiver Decoder
LNB	Low Noise Block
PIP	Primary Injection Point
RBM	Receive Broadcast Manager
SBM	Satellite Broadcast Manager
SRT	Shipboard Receive Terminal
SSRT	Submarine Receive Terminal
TIM	Theater Information Manager
TIP	Theater Injection Point

Back channel. A communications capability that exists outside the GBS system which allows end users to define "User Pull" requests and is used to ensure reliable delivery of information by the GBS system.

bit stream. The modulated RF signal that is the broadcast data stream.

broadcast data stream. The aggregation of file and stream products into a continuous digital stream to be transmitted to the space segment. Broadcast data streams are created by the Satellite Broadcast Manager, processed and transmitted to the space segment by the injection terminal, and received and processed by the receive suite (receive terminal, cryptographic equipment and Receive Broadcast Manager) for subsequent dissemination to end user systems.

broadcast management. The set of functions, processes, and systems required to collect, assemble, prioritize, transmit encrypt/decrypt, and disseminate information provided from national and theater sources to end user systems. Broadcast management can be subdivided into transmit broadcast management and receive broadcast management.

broadcast management center. A facility that contains the Satellite Broadcast Management functions. See also Transmit Broadcast Manager.

broadcast management segment. One of the three segments of the GBS system, which includes the Theater Information Manager, Satellite Broadcast Manager, and Receive Broadcast Manager.

Defense Information Infrastructure. The resources identified by the Defense Information Systems Agency (DISA) as critical for the flow of information within the DoD. Interoperability and multi-path technologies are being applied to the DII to make it as flexible as possible. DISA is also working on a multi-level security capability for the DII.

Defense Information Systems Network. A network of communications paths that support information transfer within the DoD.

end user. The ultimate recipient and/or user of the information products broadcast by the GBS.

end user system. An end user owned and operated system that uses information provided via the GBS.

file. A discrete/fixed size information product. Imagery, weather information, maps, and Air Tasking Orders (ATO) are examples of file products.

fixed. Not capable of being moved.

Global Broadcast Service. An acquisition category (ACAT) ID DoD program to provide a continuous, high data rate, one-way satellite broadcast capability able to support the simultaneous transmission and receipt of national and theater level generated information products to forces deployed, on the move (in transit), or in garrison.

global coverage. 90° north to 65° south latitude, 180° west to 180° east longitude.

ground receive terminal. A small satellite antenna and receive equipment that will receive and convert the downlink GBS RF signal into a bit stream.

information management. The set of functions, processes, and systems associated with obtaining information products from national and theater sources and providing them to users via any available communications path.

information products. File and stream products from national and theater sources to be delivered to end users by the GBS system.

information source. A provider of file or stream information products. Information sources are categorized as national and theater.

injection points. The hardware and software that implements the functions necessary to transmit broadcast data streams to the space segment. Injection Points are categorized as Primary Injection Points and Theater Injection Points.

integrated receiver decoder. Receives the radio frequency signal from the LNB, demodulates the signal, and separates the video and data information streams.

mobile. Capable of communicating while moving.

near worldwide coverage. 65° north latitude to 65° south latitude, with longitude coverages limited by the UHF Follow-On satellite footprint.

near continuous. Information that is either a continuous data stream of long duration (up to hours) *(i.e. real-time UAV products)* or is bursts of information at regular *(i.e. situation awareness products)* or irregular *(i.e. threat warning products)* time internals requiring connectivity on-demand.

primary injection point. A fixed injection system that provides the primary uplink of the broadcast data streams from the broadcast management segment to the space

segment. For GBS Phase 2, there will be one PIP associated with each GBS UFO satellite.

receive broadcast manager. The hardware and software that implements the receive broadcast management functions necessary to process the downlink broadcast data streams for subsequent dissemination to end users systems and services.

receive broadcast management. The set of functions, processes, and systems associated with receiving and disseminating the file and stream information contained within the broadcast to end users. Receive broadcast management functions include, for example: decryption and encryption, storage, de-multiplexing, filtering, broadcast schedule tuning, network management, configuration control of receive terminal equipment, supporting "Smart Push" and "User Pull" requests, and receiving and processing cryptographic key material sent over the air.

receive site. A location capable of receiving the GBS downlink directly from the satellite. Receive sites will be fixed, transportable, and mobile.

receive suite. The receive terminal, cryptographic equipment, and receive broadcast management hardware and software (i.e., Receive Broadcast Manager) required to support an end user's information delivery and dissemination requirements.

receive terminal. The hardware (antenna and associated equipment such as support structure and tracking mechanism, low noise block (LNB) and integrated receiver decoder (IRD) or "settop box") and software that implements the functions necessary to receive the downlink broadcast data streams and convert them to bit streams for subsequent processing and dissemination by the Receive Broadcast Manager. Receive terminals are categorized as: fixed ground (FGRT), transportable ground (TGRT), airborne (ART), shipboard (SRT), submarine (SSRT), ground mobile (GMRT), and Manpack (MRT).

satellite broadcast manager. The hardware and software that implements the broadcast management functions necessary to assemble the uplink broadcast data streams for subsequent transmission to the space segment.

satellite broadcast management. The set of functions, processes, and systems associated with collecting information products, assembling broadcast data streams, and transmitting these streams to the injection point for uplink to the space segment. satellite broadcast management functions include, for example: enforcing the Joint Chiefs of Staff resource apportionment and other policies and procedures, creating and disseminating broadcast schedules, collecting information products from national and theater sources, decryption and encryption, authentication, storage, assembling and routing broadcast data streams, network management, configuration control of broadcast management and injection point equipment, configuration control of receive suite equipment (to the extent required to ensure correct delivery of files and streams), controlling the flow of information from the DII and other sources, ensuring reliable delivery of information products, supporting "Smart Push" and "User Pull" requests, and performing over-the-air rekey of receive terminals.

scaleable architecture. The notion that the GBS system architecture will support an array of capabilities required to meet the end users' operational needs. For example, the transmit and receive data rates will vary with the capabilities of the injection and receive terminals. Also, the capability of the receive suite will vary depending on whether the equipment will be used in a stand-alone or networked configuration.

smart push. The capability for the end user to define information requirements in advance so that the GBS system can provide those information products as they become available, and in accordance with established priorities.

space segment. One of the three segments of the GBS system, consisting of the broadcast satellite packages and satellite command and control systems.

stream. A continuous/variable duration information product that originates from a national or theater source. Real time video is an example of a stream product.

terminal segment. One of the three segments of the GBS system, consisting of the injection points and receive terminals.

theater information management. The set of functions, processes, and systems that are controlled by the theater commander (e.g., CINC) to manage the dissemination of information at the theater level.

theater information manager. The TIM is the CINC's mechanism for exercising control over what, when, and to whom information is disseminated within their Area of Responsibility (AOR) or to their forces supporting one of the geographic CINCs.

theater injection. The capability to broadcast information directly from within a theater of operations.

theater injection point. A transportable injection system that provides the capability for theater commanders to transmit information directly from within a theater to the GBS space segment. Although functionally equivalent to a PIP, the TIP, as a transportable system, also includes the theater broadcast management segment.

time critical information. Information that has high urgency or perishability requiring connectivity on-demand.

transportable. Capable of being moved from one location to another and communicating from a fixed location.

uplink site. A location capable of transmitting the GBS uplink directly to the space segment. Uplink sites will be fixed (PIP), and transportable (TIP).

user pull. The capability for end users to define specific information to be broadcast on demand in response to operational circumstances, or the actual end user request for specific information to be broadcast on demand. "User Pull" requests are made via existing (non-GBS) communications means available to the user.

virtual injection. The process of utilizing other (e.g. fiber, leased satellite, MILSATCOM, etc.) communications paths to transmit in-theater generated information to a Primary Injection Point for broadcast to users in theater.

worldwide coverage. 65° north latitude to 65° south latitude, 180° west to 180° east longitude.

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